Summary of the 2007 Pacific halibut stock assessment

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Abstract

As in 2006, the stock assessment was done by fitting the assessment model to a coastwide dataset to estimate total biomass, and then apportioning the total among regulatory areas in accordance with survey estimates of relative abundance. Coastwide exploitable biomass in 2008 is estimated to be 361 million pounds, down from the 414 million estimated last year. About half of the decrease is due to a change in the parameterization of survey catchability in the model, and the other half to lower commercial and survey catch rates in 2007. Total CEY is 69 million pounds.

Introduction

Each year the International Pacific Halibut Commission (IPHC) staff assesses the abundance and potential yield of Pacific halibut using all available data from the commercial fishery and scientific surveys (Appendix A). A biological target level for total removals from each regulatory area is calculated by applying a fixed harvest rate to the estimate of exploitable biomass in that area. This target level is called the "constant exploitation yield" or CEY for that area in the coming year. The corresponding target level for catches in directed fisheries subject to allocation is called the fishery CEY. It comprises the commercial setline catch in all areas plus the sport catch in Areas 2A and 2B. It is calculated by subtracting from the total CEY an estimate of all unallocated removals—bycatch of legal-sized fish, wastage of legal-sized fish in the halibut fishery, fish taken for personal use, and sport catch except in Areas 2A and 2B. Staff recommendations for catch limits in each area are based on the estimates of fishery CEY but may be higher or lower depending on a number of statistical, biological, and policy considerations. Similarly, the Commission's final quota decisions are based on the staff's recommendations but may be higher or lower.

For many years the staff assessed the stock in each regulatory area by fitting a model to the data from that area. This procedure relied on the assumption that the stock of fish of catchable size in each area was closed, meaning that net migration was negligible. A growing body of evidence from both the assessments (Clark and Hare 2007a) and the ongoing mark-recapture experiment (Webster and Clark 2007) shows that there is probably a continuing eastward net migration of catchable fish from the western Gulf of Alaska (Areas 3B and 4) to the eastern side (Area 2). The effect of this migration on the closed-area stock assessments was to produce underestimates of abundance in the western areas and overestimates in the eastern areas. To some extent this was almost certainly been the case for some time, meaning that exploitation rates were well above the target level in Area 2 and a disproportionate share of the catches have been taken from there.

In order to obtain an unbiased estimate of the coastwide stock in the 2006 assessment, the staff built a coastwide data set and fitted the model to it. Exploitable biomass in each regulatory area was estimated by apportioning the total in proportion to an estimate of stock distribution derived from the setline survey catch rates (CPUE). Specifically, an index of abundance in each area was calculated by multiplying survey CPUE (running 3-year average) by total bottom area

between 0 and 300 fm. The logic of this index is that survey CPUE can be regarded as an index of density, so multiplying it by bottom area gives a quantity proportional to total abundance. The estimated proportion in each area is then the index value for that area divided by the sum of the index values. This year's assessment uses the same procedure.

Description of the assessment model

The IPHC assessment model is age- and sex-structured. Commercial and survey selectivity are both estimated as piecewise linear functions of observed mean length at age/sex in survey catches. (There is a 32" minimum size limit in the commercial fishery.) Commercial catchability is normally allowed to vary from year to year with a penalty of 0.03 on log differences. Survey catchability is normally held constant, although some variation was allowed in both this year's and last year's production fits. The model is fitted to commercial and survey catch at age and CPUE. Clark and Hare (2006) provide a full account of model structure and fitting procedures.

The closed-area and coastwide model fits differ in parameterization and likelihood. Some of the closed-area data sets are quite noisy, so the closed-area version is more parsimonious and it is weighted. Specifically, the catchability, selectivity and natural mortality parameters are all unisex; the estimated selectivity schedules are strongly smoothed; the model is fitted only to total CPUE (rather than CPUE at age/sex); and a heavy weight is placed on the CPUE data series to assure satisfactory agreement. The coastwide data are not noisy, so the coastwide version of the model can have sex-specific parameters, weaker selectivity smoothing, and neutral data weighting. It is fitted to CPUE at age/sex as well as total CPUE.

Alternative model fits

In the 2006 coastwide assessment (Clark and Hare 2007b), estimated survey catchability was allowed to vary somewhat because it was found that actual survey catchability had varied substantially. This was shown by model fits in which present abundance was fixed at a range of levels by fixing the terminal fishing mortality rate as in a virtual population analysis (VPA) and then estimating survey catchability as a free parameter in each year (Fig. 1). These fits showed that survey catchability happened to be high in the first year of the data (1997) and low in the last year (2006), resulting in a spurious appearance of a decline in abundance. To neutralize that feature, survey catchability was estimated independently for the first and last years, which effectively meant disregarding those data points and estimating a constant survey catchability from the remaining data (1998-2005).

In this year's assessment some other ways of dealing with variable survey catchability were considered. The candidate models were:

(i) Vanilla: the conventional model, with constant survey catchability in all years.

(ii) HiLoSQ: last year's production model, with three values of survey catchability estimated (1997, 1998-2005, 2006-2007).

(iii) WobbleSQ: survey catchability estimated for each year, but with a penalty of 0.05 on log differences. This is similar to the treatment of commercial catchability.

(iv) TrendlessSQ: same as WobbleSQ, but with the additional requirement that a regression of estimated survey catchability on year have zero slope. This means that survey catchability was allowed to vary but not to show any trend over time.

Table 1 shows features of the candidate model fits and some others. WobbleSQ has the lowest AIC score, but TrendlessSQ is nearly as good, and we think it is appropriate to disallow trends in survey catchability over time, so that is our chosen production model.

The last two fits in Table 1 show the effect of commercial CPUE on the biomass estimate. "No commercial CPUE" is a fit in which commercial CPUE is disregarded, and "CAGEAN" is a fit in which commercial catchability is held constant, so that commercial and survey CPUE are given equal influence. Evidently commercial CPUE tends to increase the biomass estimate, but not greatly.

Effect of the 2007 data on abundance estimates

Coastwide commercial and survey CPUE both declined by 5-10% from 2006 to 2007 (Fig. 2; Appendix A tables A2 and A3). As a result the 2007 coastwide and closed-area model fits mostly revise downward the estimates of abundance at the beginning of 2007 made in the 2006 assessment (Table 2). At the same time the 2007 fits show an increase in abundance between the beginning of 2007 and the beginning of 2008, so last year's estimates of 2007 biomass and this year's estimates of 2008 biomass are not very different in most cases. Exceptions are Areas 2C and 4A where the closed-area estimates decrease significantly.

The coastwide estimate of exploitable biomass in 2008 is 361 M lb compared with 414 last year. About half of this difference is due to the change from the HiLoSQ to the TrendlessSQ model fit. The HiLoSQ biomass estimate in 2008 is 386 M lb.

Area-specific biomass and CEY estimates

Area-specific estimates of biomass are calculated by survey apportionment as they were last year, with the difference that this year a depth-stratified mean survey CPUE has been used, which results in about a 40% increase in the Area 2A apportionment, about a 5% decrease in the Area 3A apportionment, and very small increases in most other apportionments. The area-specific estimates from last year's and this year's coastwide and closed-area assessments are shown in Tables 3 and 4.

The target harvest rate for the stock as a whole is 20% of exploitable biomass, and this rate is normally applied to the biomass estimate for each area to calculate the total CEY for that area. A precautionary rate of 15% has been used in Areas 4B and 4CDE in recent years, and last year a transitional rate of 25% was used in Area 2 to partly offset the effect of the lower biomass estimates in Area 2 produced by the coastwide assessment. This year the staff has used the biologically based 20% rate in all areas (except 4B and 4CDE). This does not preclude transitional measures, but moves that decision out of the assessment and into the catch limit recommendation and decision process where it belongs.

Relative to last year's numbers, total CEY is about the same in Area 2A because the higher survey apportionment offsets the lower target harvest rate. In Areas 2B and 2C the estimated biomass is about the same as last year, but total CEY is lower because of the lower target harvest rate. In every area within Area 2, fishery CEY is on the order of half of the 2007 catch limit.

In Area 3A estimated biomass is lower because of the lower coastwide estimate and slightly lower survey apportionment to Area 3A, and total CEY is correspondingly lower. In Area 3B total CEY is lower because of the lower coastwide value, but fishery CEY is still well above the 2007 catch limit. In Area 4A the biomass estimate is lower because of lower survey CPUE, and

fishery CEY for 2008 is not much larger than the 2007 catch limit. In Areas 4B and 4CDE total CEY is little changed.

The staff believes that survey apportionment is the most objective and consistent method of estimating the biomass distribution among areas and therefore the best distribution of total CEY, if the aim is proportional harvest. A disproportionate share of the harvest has been taken from Area 2 for decades, so some level of disproportionality was clearly sustainable by the stock with the exploitation pattern that prevailed during that period. Increasing catches from the western portion of the stock in the last decade have altered the exploitation pattern, so the historical high levels of removals from Area 2 may no longer be sustainable. Alternative CEY apportionments under a variety of rules are shown for information in Table 6. The staff does not advocate any of them and would in fact oppose some, such as apportionment on the basis of bottom area alone or an index incorporating commercial CPUE.

References

Clark, W.G., and Hare, S.R. 2006. Assessment and management of Pacific halibut: data, methods, and policy. Int. Pac. Halibut Comm. Sci. Rep. 83.

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Clark, W.G., and Hare, S.R. 2007b. Assessment of the Pacific halibut stock at the end of 2006. Int. Pac. Halibut Comm. Report of Research and Assessment Activities 2006:98-128.

Webster, R., and Clark, W.G. 2007. Analysis of PIT tag reoveries through 2006. Int. Pac. Halibut Comm. Report of Assessment and Research Activities 2006:129-138.

Table 1. Alternative coastwide model fits. The first two are coastwide fits that have the same parameterization as the closed-area fits.

Model	Number of parameters	Deviance	AIC	Exploitable biomass
Closed-area parameters Closed-area likelihood	121	NA	NA	321
Closed-area parameters Coastwide likelihood	121	716	958	341
Vanilla	136	524	796	337
WobbleSQ	155	479	789	338
HiLoSQ	138	520	796	386
TrendlessSQ	155	480	790	361
No commercial CPUE	145	504	794	344
CAGEAN	134	553	821	400

Table 2. Effect of the 2007 data on closed-area and coastwide abundance estimates.

Area	2007 ebio 2006 assessment Data as of 11/06	2007 ebio 2006 assessment Data as of 11/07	2007 ebio 2007 assessment Data as of 11/07	2008 ebio 2007 assessment Data as of 11/07
Closed-area assessments:				
2A	4.9	5.1	4.0	4.6
2B	39	41	33	37
2C	57	55	45	49
3A	174 [1]	170	169	169
3B	52	53	47	54
4A	17	14	11	11
4B	10	12	15	14
2A-4B sum	354	350	324	339
4CDE	58	52	52	52
Total	412	402	376	391
Coastwide assessment:				
2A-4B sum (90% of total)	339	333	297	325
4CDE	38	37	33	36
Total	377	370	330	361

Notes:

[1] Recalculated to be consistent with present treatment of Area 3A survey CPUE (full-area CPUE = 81% of partial-area CPUE rather than 75%). Value reported last year was 186.

Table 3. Estimates of 2007 exploitable biomass and CEY from the 2006 assessment (2006 RARA, p. 107).

	Area 2A	Area 2B	Area 2C	Area 3A	Area 3B	Area 4A	Area 4B	Area 4CDE	Total
Coastwide assessment [1]									
2007 exploitable biomass	3.7	27	33	176	86	29	19	41	414
Proportion of total	0.009	0.065	0.080	0.423	0.208	0.069	0.045	0.101	1.000
Target harvest rate	0.25	0.25	0.25	0.20	0.20	0.20	0.15	0.15	~0.20
Total CEY	0.93	6.75	8.25	35.20	17.20	5.80	2.85	6.15	83.13
Other removals [2]	0.27	0.53	3.79	7.89	0.43	0.57	0.29	2.30	16.07
2007 fishery CEY [2]	0.66	6.22	4.46	27.31	16.77	5.23	2.56	3.85	67.06
Area assessments [1]									
2007 exploitable biomass	4.9	39	57	186	52	17	10	50	416
Proportion of total	0.012	0.094	0.137	0.447	0.125	0.041	0.024	0.120	1.000
Target harvest rate	0.20	0.20	0.20	0.20	0.20	0.20	0.15	0.15	~0.20
Total CEY	1.00	7.80	11.40	37.20	10.40	3.40	1.50	7.50	80.20
Other removals [2]	0.27	0.53	3.79	7.89	0.43	0.57	0.29	2.30	16.07
2007 fishery CEY [2]	0.73	7.27	7.61	29.31	9.97	2.83	1.21	5.20	64.13
2007 catch limit [3]	1.34	11.47	8.51	26.20	9.22	2.89	1.44	4.10	65.17

Notes:

[1] "Coastwide assessment" refers to the coastwide model fit with survey apportionment of the total biomass estimate among regulatory areas. "Area assessments" are the closed-area model fits.

[2] "Other removals" comprise legal-sized wastage, legal-sized bycatch, personal use, and in most areas sport catch. In Areas 2A and 2B sport catch is included in fishery CEY rather than in other removals.

[3] "Catch limit" includes sport as well as commercial catch in Areas 2A and 2B.

Table 4. Estimates of 2008 exploitable biomass and CEY from the 2007 assessment.

	Area 2A	Area 2B	Area 2C	Area 3A	Area 3B	Area 4A	Area 4B	Area 4CDE	Total
Coastwide assessment [1]									
2008 exploitable biomass	4.7	25.6	32.5	144.8	74.0	21.3	20.2	37.9	361
Proportion of total	0.013	0.071	0.090	0.401	0.205	0.059	0.056	0.105	1.000
Target harvest rate	0.20	0.20	0.20	0.20	0.20	0.20	0.15	0.15	<0.20
Total CEY	0.94	5.12	6.50	28.96	14.80	4.26	3.03	5.69	69.30
Other removals [2]	0.29	0.47	2.59[3]	6.71[3]	0.53	0.75	0.33	2.01	13.68
2008 fishery CEY [2]	0.65	4.65	3.92	22.25	14.27	3.51	2.71	3.68	55.62
Area assessments [1]									
2008 exploitable biomass	4.6	37	49	169	54	11	14	52	391
Proportion of total	0.012	0.095	0.125	0.432	0.138	0.028	0.036	0.133	0.999
Target harvest rate	0.20	0.20	0.20	0.20	0.20	0.20	0.15	0.15	<0.20
Total CEY	0.92	7.40	9.80	33.80	10.80	2.20	2.10	7.80	74.82
Other removals [2]	0.29	0.47	3.09[3]	6.71[3]	0.53	0.75	0.33	2.01	14.18
2008 fishery CEY [2]	0.63	6.93	6.71	27.09	10.27	1.45	1.77	5.79	60.64

Notes:

[1] "Coastwide assessment" refers to the coastwide model fit with survey apportionment of the total biomass estimate among regulatory areas. "Area assessments" are the closed-area model fits.

[2] "Other removals" comprise legal-sized wastage, legal-sized bycatch, personal use, and in most areas sport catch. In Areas 2A and 2B sport catch is included in fishery CEY rather than in other removals.

[3] The sport catch component in these figures is the adopted guideline harvest level (GHL), which is lower than the actual 2007 catch in Area 2C and higher in Aea 3A.

Table 5. Other removals in detail. Sport catch figures for Areas 2C and 3A are actual catches not GHL levels as in Table 4.

	Area 2A	Area 2B	Area 2C	Area 3A	Area 3B	Area 4A	Area 4B	Area 4CDE	Total
Sport catch	0.52	1.77	2.55	5.05	0.01	0.05	0.00	0.00	9.93
Legal-sized bycatch	0.25	0.15	0.21	0.99	0.45	0.66	0.32	1.90	4.93
Pesonal use	0.04	0.30	0.58	0.38	0.05	0.03	0.00	0.11	1.49
Legal-sized wastage	0.00	0.02	0.02	0.05	0.02	0.01	0.01	0.00	0.13
Total	0.81	2.24	3.36	6.47	0.53	0.75	0.33	2.01	16.50
Total excl.sport catch in Areas 2A and 2B	0.29	0.47	3.36	6.47	0.53	0.75	0.33	2.01	14.21
Sublegal discard mortality (shown for information; not taken off total CEY)	0.02	0.44	0.27	0.92	0.42	0.13	0.02	0.07	2.29

Table 6. Shares of total CEY by area according to various apportionment rules.

Rule	Area 2A	Area 2B	Area 2C	Area 3A	Area 3B	Area 4A	Area 4B	Area 4CDE	Total
Survey apportionment (CPUE x bottom area)	0.013	0.071	0.090	0.401	0.205	0.059	0.056	0.105	1.000
2008 exploitable biomass from 2007 closed-area assessments	0.012	0.095	0.125	0.432	0.138	0.028	0.036	0.133	0.999
Historical recruitment from 2007 closed-area assessments (1987-1996)	0.02?	0.107	0.098	0.451	0.161	0.046	0.018	0.10?	1.001
Share of total catch (1990-2007)	0.017	0.144	0.140	0.366	0.142	0.065	0.035	0.091	1.000
Share of bottom 0-300 fm (excl. EBS shelf outside 4C)	0.066	0.160	0.082	0.256	0.154	0.094	0.078	0.111	1.001
Commercial apportionment (CPUE x bottom area)	0.035	0.113	0.055	0.401	0.162	0.088	0.066	0.080	1.000

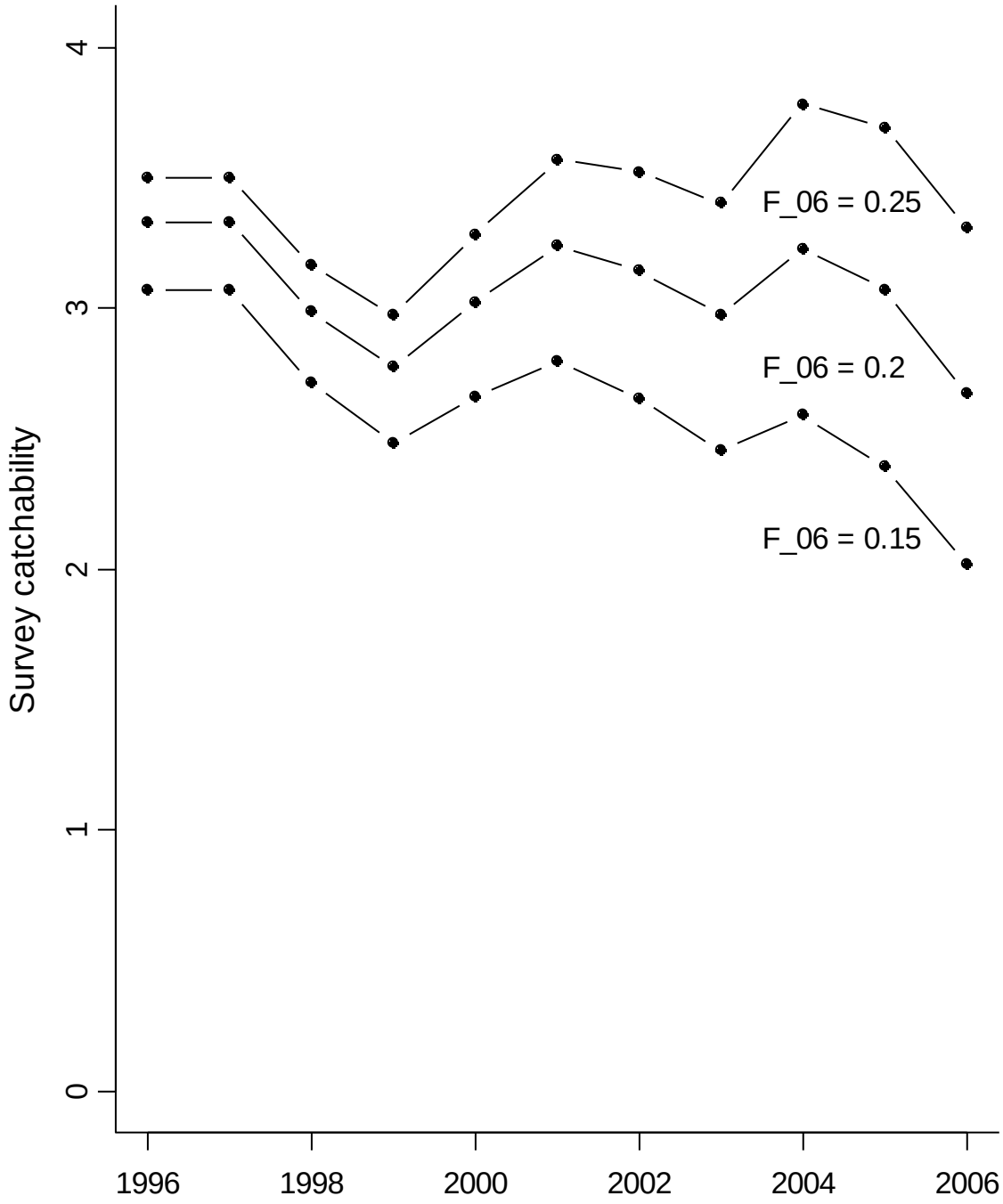

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Figure 1. Calculated values of survey catchability in VPA-like fits of the model in the 2006 assessment. The labels refer to the value of the fixed terminal fishing mortality rate; e.g. "F_06 = 0.2" means that the fishing mortality rate in 2006 was set to 0.20.

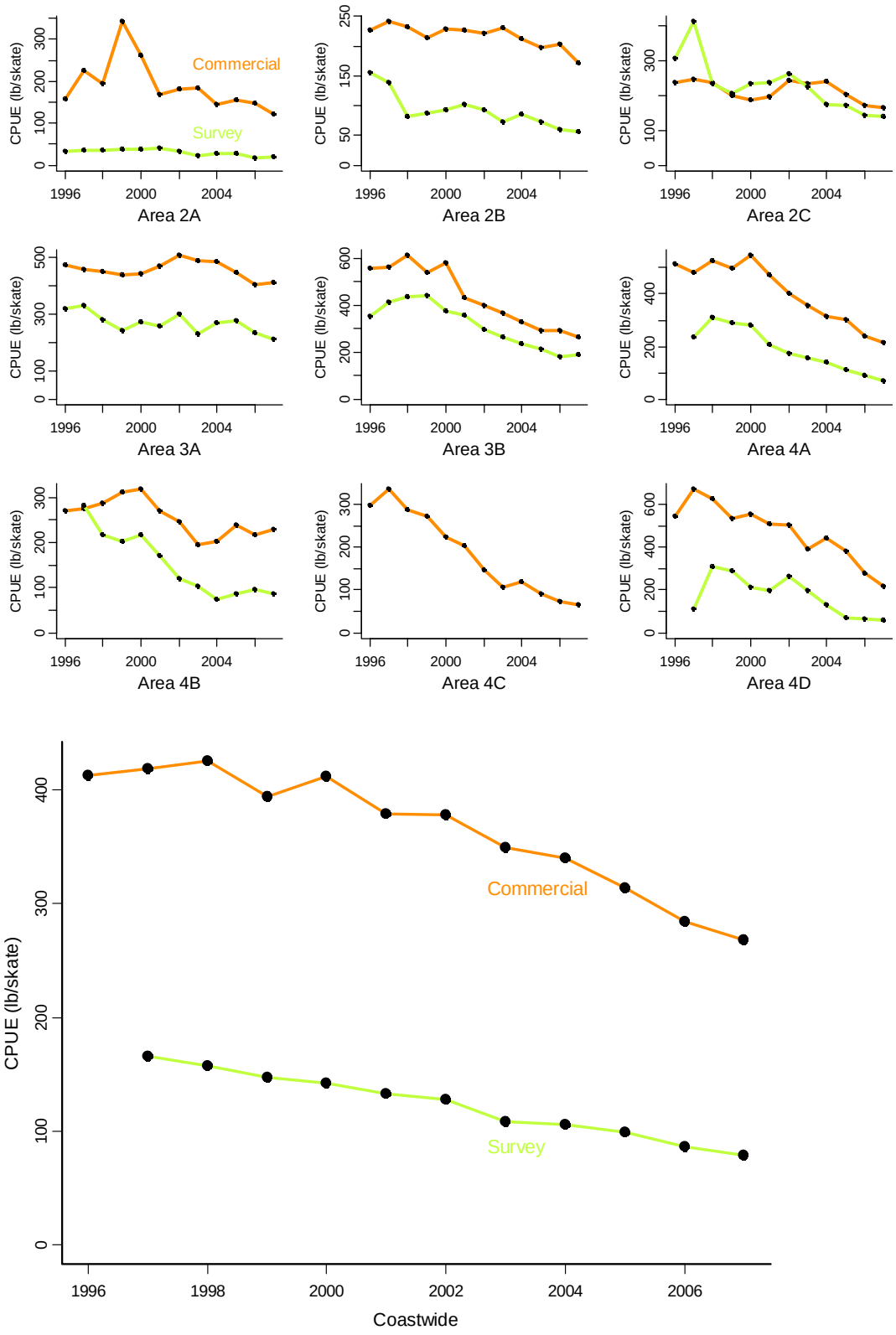

Figure 2. Commercial and survey CPUE by area (above) and coastwide (below).

Appendix A. Selected fishery and survey data summaries.

Table A1. Commercial catch (million pounds, net weight). Figures include IPHC research catches. Sport catch in Areas 2A and 2B is *not* included in this table.

	2A	2B	2C	3A	3B	4	4A	4B	4C	4D	4E	Total
1974	0.52	4.62	5.60	8.19	1.67	0.71	---	---	---	---	---	21.31
1975	0.46	7.13	6.24	10.60	2.56	0.63	---	---	---	---	---	27.62
1976	0.24	7.28	5.53	11.04	2.73	0.72	---	---	---	---	---	27.54
1977	0.21	5.43	3.19	8.64	3.19	1.22	---	---	---	---	---	21.88
1978	0.10	4.61	4.32	10.30	1.32	1.35	---	---	---	---	---	22.00
1979	0.05	4.86	4.53	11.34	0.39	1.37	---	---	---	---	---	22.54
1980	0.02	5.65	3.24	11.97	0.28	0.71	---	---	---	---	---	21.87
1981	0.20	5.66	4.01	14.23	0.45	---	0.49	0.39	0.30	0.01	0.00	25.74
1982	0.21	5.54	3.50	13.52	4.80	---	1.17	0.01	0.24	0.00	0.01	29.01
1983	0.26	5.44	6.38	14.14	7.75	---	2.50	1.34	0.42	0.15	0.01	38.39
1984	0.43	9.05	5.87	19.77	6.69	---	1.05	1.10	0.58	0.39	0.04	44.97
1985	0.49	10.39	9.21	20.84	10.89	---	1.72	1.24	0.62	0.67	0.04	56.10
1986	0.58	11.22	10.61	32.80	8.82	---	3.38	0.26	0.69	1.22	0.04	69.63
1987	0.59	12.25	10.68	31.31	7.76	---	3.69	1.50	0.88	0.70	0.11	69.47
1988	0.49	12.86	11.36	37.86	7.08	---	1.93	1.59	0.71	0.45	0.01	74.34
1989	0.47	10.43	9.53	33.74	7.84	---	1.02	2.65	0.57	0.67	0.01	66.95
1990	0.32	8.57	9.73	28.85	8.69	---	2.50	1.33	0.53	1.00	0.06	61.60
1991	0.36	7.19	8.69	22.93	11.93	---	2.26	1.51	0.68	1.44	0.10	57.08
1992	0.44	7.63	9.82	26.78	8.62	---	2.70	2.32	0.79	0.73	0.07	59.89
1993	0.50	10.63	11.29	22.74	7.86	---	2.56	1.96	0.83	0.84	0.06	59.27
1994	0.37	9.91	10.38	24.84	3.86	---	1.80	2.02	0.72	0.71	0.12	54.73
1995	0.30	9.62	7.77	18.34	3.12	---	1.62	1.68	0.67	0.64	0.13	43.88
1996	0.30	9.54	8.87	19.69	3.66	---	1.70	2.07	0.68	0.71	0.12	47.34
1997	0.41	12.42	9.92	24.63	9.07	---	2.91	3.32	1.12	1.15	0.25	65.20
1998	0.46	13.17	10.20	25.70	11.16	---	3.42	2.90	1.26	1.31	0.19	69.76
1999	0.45	12.70	10.14	25.32	13.84	---	4.37	3.57	1.76	1.89	0.26	74.31
2000	0.48	10.81	8.44	19.27	15.41	---	5.16	4.69	1.74	1.93	0.35	68.29
2001	0.68	10.29	8.40	21.54	16.34	---	5.01	4.47	1.65	1.84	0.48	70.70
2002	0.85	12.07	8.60	23.13	17.31	---	5.09	4.08	1.21	1.75	0.56	74.66
2003	0.82	11.79	8.41	22.75	17.23	---	5.02	3.86	0.89	1.96	0.42	73.19
2004	0.88	12.16	10.23	25.17	15.46	---	3.56	2.72	0.95	1.66	0.31	73.11
2005	0.80	12.33	10.63	26.03	13.17		3.40	1.98	0.53	2.58	0.37	71.82
2006	0.83	12.01	10.49	25.71	10.79	---	3.33	1.59	0.49	2.37	0.37	67.98
2007	0.78	9.74	8.49	26.31	9.42	---	2.81	1.41	0.55	2.72	0.58	62.81

Table A2. Commercial CPUE (net pounds per skate).

Values before 1984 are raw J-hook catch rates, with no hook correction. 1983 is excluded because it consists of a mixture of J- and C-hook data. No value is shown for area/years after 1980 with fewer than 500 skates of reported catch/effort data. Total column recomputed in 2007 with new bottom area numbers.

	2A	2B	2C	3A	3B	4A	4B	4C	4D	4E	Total
J-hook CPUE:											
1974	59	64	57	65	57	---	---	---	---	---	---
1975	59	68	53	66	68	---	---	---	---	---	---
1976	33	53	42	60	65	---	---	---	---	---	---
1977	83	61	45	61	73	---	---	---	---	---	---
1978	39	63	56	78	53	---	---	---	---	---	---
1979	50	48	80	86	37	---	---	---	---	---	---
1980	37	65	79	118	113	---	---	---	---	---	---
1981	33	67	145	142	160	158	99	110	---	---	---
1982	22	68	167	170	217	103	---	91	---	---	---
1983	---	---	---	---	---	---	---	---	---	---	---
C-hook CPUE:											
1984	63	148	314	524	475	366	161	---	197	---	357
1985	62	147	370	537	602	333	234	---	330	---	400
1986	60	120	302	522	515	265	---	427	239	---	356
1987	57	131	260	504	476	341	220	384	---	---	349
1988	134	137	281	503	655	453	224	---	201	---	392
1989	124	134	258	455	590	409	268	331	384	---	376
1990	168	175	269	353	484	434	209	288	381	---	334
1991	158	148	233	319	466	471	329	223	398	---	328
1992	115	171	230	397	440	372	278	249	412	---	336
1993	147	208	256	393	514	463	218	257	851	---	392
1994	93	215	207	353	377	463	198	167	480	---	326
1995	116	219	234	416	476	349	189	---	475	---	351
1996	159	226	238	473	556	515	269	---	---	---	413
1997	226	241	246	458	562	483	275	335	671	---	419
1998	194	232	236	451	611	525	287	287	627	---	425
1999	---	213	199	437	538	500	310	270	535	---	394
2000	263	229	186	443	577	547	318	223	556	---	412
2001	169	226	196	469	431	474	270	203	511	---	379
2002	181	222	244	507	399	402	245	148	503	---	378
2003	184	231	233	487	364	355	196	105	389	---	349
2004	145	212	240	485	328	315	202	120	444	---	340
2005	155	197	203	446	293	301	238	91	379	---	314
2006	147	202	170	403	292	241	218	72	280	---	284
2007	121	172	164	410	261	213	230	66	216	---	268

Table A3. IPHC setline survey CPUE of legal sized fish in weight (net pounds per skate). Figures refer to entire areas. For cases where only part of an area was fished (e.g., northern 2B, western 3A), the CPUE shown is an adjusted value. *No hook corrections* are applied; J-hook values are raw J-hook catch rates. Area 4EBS is the eastern Bering Sea shelf, first surveyed in 2006. For other years, the 4EBS CPUE is a constructed value based on the NMFS trawl survey and the single 2006 setline data point.

	2A	2B	2C	3A	3B	4A	4B	4C	4D	4EBS	Total
J-hook surveys:											
1974	---	---	---	---	---	---	---	---	---	---	---
1975	---	---	---	---	---	---	---	---	---	---	---
1976	---	---	---	---	---	---	---	---	---	---	---
1977	---	13	---	58	---	---	---	---	---	---	---
1978	---	18	---	27	---	---	---	---	---	---	---
1979	---	NA	---	41	---	---	---	---	---	---	---
1980	---	25	---	76	---	---	---	---	---	---	---
1981	---	16	---	131	---	---	---	---	---	---	---
1982	---	21	114	130	---	---	---	---	---	---	---
1983	---	18	142	119	---	---	---	---	---	---	---
1984	---	25	---	176	---	---	---	---	---	---	---
C-hook surveys:											
1984	---	57	260	361	---	---	---	---	---	7	---
1985	---	42	260	378	---	---	---	---	---	8	---
1986	---	38	283	305	---	---	---	---	---	9	---
1987	---	NA	---	---	---	---	---	---	---	10	---
1988	---	NA	---	---	---	---	---	---	---	20	---
1989	---	NA	---	---	---	---	---	---	---	13	---
1990	---	NA	---	---	---	---	---	---	---	14	---
1991	---	NA	---	---	---	---	---	---	---	12	---
1992	---	NA	---	---	---	---	---	---	---	11	---
1993	---	93	---	261	---	---	---	---	---	22	---
1994	---	NA	---	254	---	---	---	---	---	17	---
1995	29	148	---	300	---	---	---	---	---	20	---
1996	---	156	306	317	352	---	---	---	---	25	---
1997	35	139	411	331	414	237	282	71	111	23	166
1998	---	82	232	281	435	310	216	---	---	30	157
1999	37	88	204	241	438	290	203	---	---	27	147
2000	---	93	233	272	373	282	216	---	215	20	142
2001	41	102	237	256	357	205	171	---	197	21	133
2002	33	92	261	299	297	174	119	---	263	13	128
2003	22	73	223	229	262	158	104	---	195	18	108
2004	27	86	173	270	236	142	73	---	132	18	106
2005	28	72	171	276	211	111	86	---	69	17	99
2006	16	59	144	232	181	88	95	---	63	18	86
2007	19	57	140	212	191	69	87	---	57	13	79